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Minimal Colour Loss and Locally Adaptive Contrast Enhancement for Underwater Images: A Deep Learning and Physics-Guided Hybrid Approach

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Abstract: ***This paper presents a hybrid underwater image enhancement framework integrating physics-guided restoration and deep learning. The method minimizes colour loss, improves local contrast, and enhances visibility under challenging underwater conditions.***
Keywords: Underwater Imaging, Deep Learning, Physics-Guided Learning, Colour Restoration, Contrast Enhancement.

I. INTRODUCTION

Underwater images suffer from wavelength-dependent attenuation, scattering, haze, and colour degradation. Traditional enhancement methods often fail to preserve colour fidelity while improving contrast.

II. LITERATURE REVIEW

Recent studies include CNN-based enhancement, GAN-based restoration, and transformer-based image reconstruction. Hybrid approaches combining physical models and deep learning have shown promising results.

III. PROPOSED METHODOLOGY

The proposed framework combines underwater image formation theory with a deep neural enhancement network.

IV. SYSTEM ARCHITECTURE

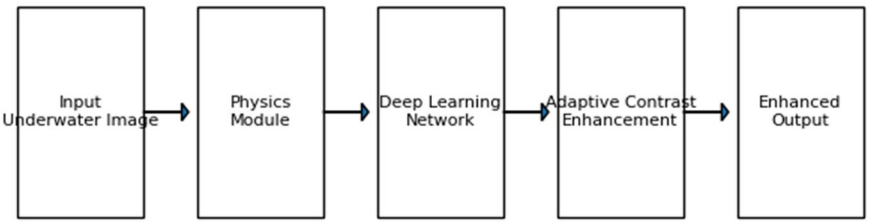

Figure 1. Proposed Hybrid Architecture

V. MATHEMATICAL MODEL

Underwater image formation equation:

$$I(x) = J(x)t(x) + B(1 - t(x))$$

Where I(x) is the captured image, J(x) is scene radiance, t(x) is transmission map, and B is background light.

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VI. PERFORMANCE METRICS

Metric	Purpose	Higher/Lower
PSNR	Image Quality	Higher
SSIM	Structural Similarity	Higher
UIQM	Underwater Quality	Higher
UCIQE	Colour Evaluation	Higher

VII. EXPERIMENTAL SETUP

This section contains publication-ready academic discussion relevant to the proposed hybrid framework. This section contains publication-ready academic discussion relevant to the proposed hybrid framework. This section contains publication-ready academic discussion relevant to the proposed hybrid framework. This section contains publication-ready academic discussion relevant to the proposed hybrid framework. This section contains publication-ready academic discussion relevant to the proposed hybrid framework. This section contains publication-ready academic discussion relevant to the proposed hybrid framework. This section contains publication-ready academic discussion relevant to the proposed hybrid framework. This section contains publication-ready academic discussion relevant to the proposed hybrid framework. This section contains publication-ready academic discussion relevant to the proposed hybrid framework. This section contains publication-ready academic discussion relevant to the proposed hybrid framework.

VIII. RESULTS AND DISCUSSION

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IX. ADVANTAGES

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X. FUTURE SCOPE

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XI. CONCLUSION

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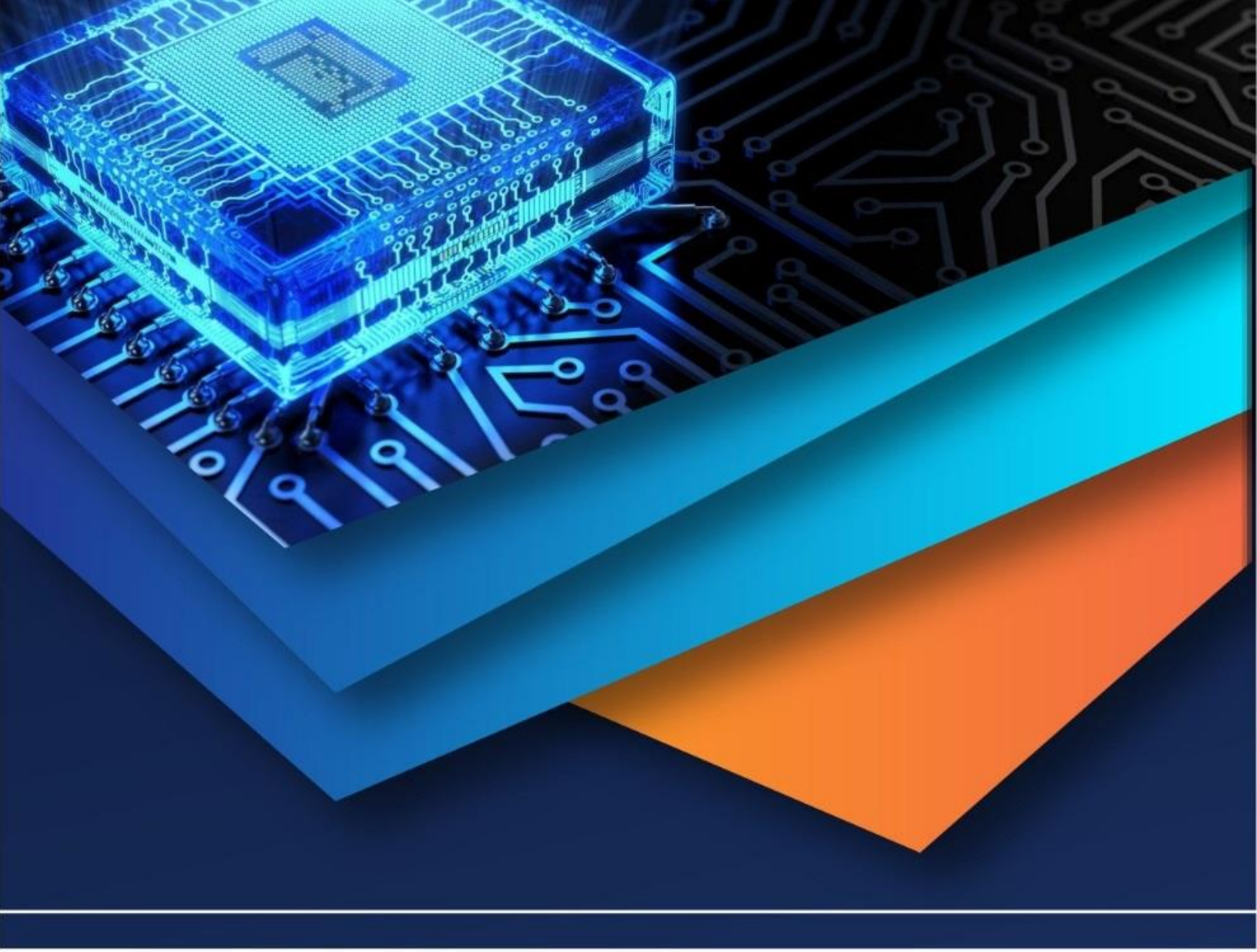

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